

REMARKS

This is in response to the Office Action dated February 7, 2007. In view of the foregoing amendments and following representations, reconsideration is respectfully requested.

Initially, the specification and abstract have been reviewed and revised to place the application in the preferred U.S. format. Due to the nature of the revision involved, a substitute specification has been prepared. No new matter has been added. Also enclosed is a "marked-up" copy of the original specification to show the changes that have been incorporated into the substitute specification. The enclosed copy is entitled "Version with Markings to Show Changes Made."

Further, by the above amendment, claims 6-12 have been cancelled and replaced with new claims 13-25. Note that new claims 21-25 generally correspond to the claims that were granted in the corresponding EP application.

In item 1 of the Office Action, the Examiner contends that the present application is not entitled to priority based on Norwegian application no. 20020619 filed February 8, 2002. However, this is incorrect because the International application (PCT/NO03/00029) was filed on January 31, 2003, i.e. within 12 months of the filing of the Norwegian application. The present application is a national stage application, and thus the filing date is January 31, 2003. See MPEP 1893. Accordingly, the Examiner is requested to indicate that the present application is in fact entitled to the priority claim based on the underlying Norwegian application.

Next, in item 2 of the Office Action, the Examiner indicates that the drawings do not show pipe 3 described in the specification on page 2, line 29. The reference to pipe 3 is the result of a typographical error. Accordingly, the specification has been amended to change reference numeral "3" to -2-.

Next, in item 3 of the Office Action, the Examiner correctly indicates that the originally filed drawing figure does not show the claimed venturi or a perforated plate. Accordingly, the original drawing figure has been replaced with corrected drawing figures 1-3. In particular, Fig. 1 corresponds to the original figure; Fig. 2 schematically shows a perforated plate positioned at an angle; and Fig. 3 schematically shows a venturi in the pipe 1. Note that claims 9, 11 and 12 do not require any particular orientation of the perforated plate. In view of the submission of the new drawing figures, it is submitted that the objection to the drawings is now clearly obviated.

Note that the specification has been amended to refer to the new drawing figures.

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Next, on pages 3-4 of the Office Action, claims 6-8 are rejected over the prior art. In particular, claim 6 is rejected under 35 U.S.C. 102(b) as being anticipated by Griffen (U.S. Patent No. 2,506,298); claims 6 and 7 are rejected under 35 U.S.C. 102(b) as being anticipated by Capuano (EP 203896); and claims 6 and 8 are rejected under 35 U.S.C. 102(b) as being anticipated by Merle (EP 210910).

It is submitted that the present invention, as embodied by the new claims, clearly patentably distinguishes over the above prior art references for the following reasons.

Griffen discloses a fluid stream directing means for changing the direction of rotation of a fluid stream. In particular, the Griffen device is a centrifugal separator unit for removing foreign particles from a gas stream. The separator unit includes an inlet conduit 2, an inlet spinner member 3, an outlet conduit 5, and a vaned member 12 for changing the spiral motion of the gas into a longitudinal motion. Note that the particles that are thrown toward the walls of the conduit 2 are removed through cover member 9, which has a plurality of apertures 9a. Accordingly, it is clear that the Griffen device is not operable to transform a dispersed liquid/gas flow into a stratified flow. The particles are removed before they can enter the second pipe, and thus, the second pipe includes only a gas flow.

Capuano discloses a rising flow separator for a liquid/gas mixture. The separator includes a separation chamber 2, and a vortex generator (fixed blading) 3 for imparting a helical motion to the rising flow to create a centrifugal force for separating the two components of the mixture. A plurality of outlets 4 are distributed for the outflow at different levels of the separated phases of the mixture. Note that tubular wall 6 forms a collection chamber for each separated phase of the flow to convey them to respective outlet ports. In particular, the gas phase is directed to outlet 8 formed in cover 9, while the liquid phase is directed to openings 10 at the base of wall 6. Thus, the Capuano device is not capable of transforming the liquid gas flow into a stratified flow as required in claims 13 and 21. Note that Capuano clearly lacks a second device, located at a transition between a first pipe and a second pipe, for stopping rotation of the liquid/gas flow. Thus, Capuano cannot anticipate claim 13 or claim 21 under 35 U.S.C. 102(b).

Merle (EP '910) discloses a cyclone separator for removing particles from a gas flow. However, similar to the Capuano separator, the Merle separator is not capable of converting a dispersed liquid/gas flow into a stratified flow. Further, the second set of blades are not located at a transition between the first pipe (10a) and the second pipe (10c). Therefore, it is submitted that the structure defined in independent claim 13 nor the process defined in independent claim 21 is disclosed or suggested by the Griffen, Capuano and Merle references taken alone or in combination.

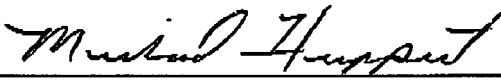
The remaining claims are allowable at least by virtue of their dependencies. Note that claims 16-19 correspond to the claims indicated by the Examiner to be allowable in the previous Office Action. Also, claim 24-25 require a perforated plate and thus should be allowable.

In view of the above, it is submitted that the present application is now clearly in condition for allowance. The Examiner therefore is requested to pass this case to issue.

In the event that the Examiner has any comments or suggestions of a nature necessary to place this case in condition for allowance, then the Examiner is requested to contact Applicant's undersigned attorney by telephone to promptly resolve any remaining matters.

Respectfully submitted,

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Device for the transformation of gas/liquid flow to laminar or stratified flow
DEVICE FOR THE TRANSFORMATION OF GAS/LIQUID FLOW TO LAMINAR
OR STRATIFIED FLOW

5 BACKGROUND OF THE INVENTION

The present invention concerns a device in connection with pipes for the transformation of dispersed liquid/gas flow into laminar or stratified flow. More precisely, the present invention concerns a device that is designed to break down drops of liquid in a gas flow, in particular a gas flow in a pipe or a pipe separator.

10 In many situations in connection with the flow of gas in a pipe, there will also be drops of liquid dispersed in the gas flow. In particular in connection with the production of oil and gas or in installations for processing, for example the separation of oil and gas, there will be flow conditions in which large quantities of liquid exist as drops dispersed in the gas. For several reasons, it is desirable to break down the drops of
15 liquid in such gas flows in order to achieve pure flows of gas/liquid.

The prior art contains the use of so-called drop traps for the separation of drops of liquid from a gas flow, but such drop traps consist of separate devices connected to the transport pipe and have external dimensions that extend far beyond the diameter of the transport pipe. Such a drop trap has a relatively expensive design and cannot be
20 used in contexts in which there is a lack of space or where it is required that the diameter of the transport pipe for the gas/liquid transported cannot be exceeded by much.

The applicant having filed the present patent application has previously filed patent applications, including PCT/NO98/00085, concerning the separation of fluids in
25 pipes or wells, for example sea bed and downhole separation of oil, water and gas. An essential precondition for achieving separation in a pipe or well is that the flow is stratified.

In connection with the extraction of oil and gas, there may be dispersed liquid/gas flow in many situations where downhole pipe separators are used.

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SUMMARY OF THE INVENTION

With the present invention, a device has been produced that transforms
5 dispersed liquid/gas flow into stratified flow in a simple fashion over a very short
distance. The solution is very effective and inexpensive and can easily be adapted to
pipe separators as described in the above application.

The present invention is characterised in that a first set of stationary guide blades
is arranged in the transport pipe. The guide blades are designed to rotate the liquid/gas
10 flow. The transport pipe is connected to a second pipe with the same or a different
diameter. A second set of blades or a device that is designed to stop the rotation of the
gas is arranged in the transition between the transport pipe and the second pipe so that
the natural flow pattern of the gas/liquid becomes stratified over a predefined distance.
~~distance, as defined in the attached claim 1.~~

15 ~~The dependent claims 2-3 define advantageous features of the present invention.~~

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic view of a transport pipe with a solution in accordance with
the present invention;

Fig. 2 is a schematic view of a transport pipe provided with a perforated plate
20 rather than a second set of guide blades as in Fig. 1; and

Fig. 3 is a schematic view of a transport pipe provided with a venturi.

DETAILED DESCRIPTION OF THE INVENTION

The present invention will be described in further detail in the following by means
25 of examples and with reference to the attached ~~figure~~ figures, which ~~show~~ show a
diagram of a transport pipe 4 with a solution in accordance with the present invention.

As shown in Fig. 1, the The special feature of the solution is that a set of
stationary guide blades 6 is arranged in the pipe 1 for transport of liquid and gas. The
guide blades are designed to rotate the dispersed liquid/gas flow. In turn, the transport
30 pipe 1 is connected to a pipe 2 with a larger diameter. A second set of guide blades 8 or

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another suitable device that is designed to stop the rotation of the gas flow is arranged in the transition between the pipe 1 and the pipe 2 with a larger diameter.

The solution works as follows. Gas with a high gas/liquid ratio flows in the pipe 1 towards the guide blades 6. The guide blades cause the gas to rotate so that the drops are slung towards the pipe wall on account of centrifugal force, partially at the end of the blades 6 and in the area 7 of the pipe towards the second set of blades 8. A film of liquid is thus produced on the pipe in the area 7 with a flow direction towards the second set of blades 8. The gas is thus cleared of drops of liquid but will continue to rotate until it meets the blades 8, which have the opposite guide direction to the first set of blades 6. The rotation of the gas is stopped here, after which the liquid will flow towards the lower part of the pipe on account of gravitational force, while the gas will flow into the upper part of the pipe, thus establishing a stratified gas/liquid flow.

A decisive precondition for achieving stratified flow, however, is that the diameter of the pipe 32 is large enough to prevent redispersion being initiated and to ensure that the natural flow pattern remains stratified.

Moreover, the ratio between the diameter of the transport pipe 1 and the diameter of the pipe with a larger diameter 2, as well as the length of the guide blades and their angle to the pipe, will depend on the flow speed, the gas/liquid ratio, the viscosity of the liquid and the density of the liquid.

It should be noted that the present invention, as it is defined in the claims, is not limited to the embodiment shown in the attached drawing and described above. Therefore, instead of the second set of guide blades 8, it is possible to use another device that stops the gas rotation after the guide blades 8. A vertical or horizontal perforated plate arranged in the transition part between the transport pipe 1 and the pipe with the larger diameter 2 may be used. Moreover, as shown in Fig. 2, the perforated plate 9 may be arranged at an angle in relation to the longitudinal direction of the pipe with a direction that is the opposite of the guide direction of the blades 6.

Although the above description concerns a solution in which the second pipe has a larger diameter, it is also possible, in given flow situations, depending on the flow speed and drop density, to use solutions in which the second pipe has a larger or

liquid to be redispersed. Otherwise it will be possible to use a constriction in the pipe in the form of a venturi 10. As shown in Fig. 3, the first set of guide blades 6 should then be arranged at the inlet of the venturi so that they extend from a place in front of the inlet of the venturi and a little way into it.

- 5 The use of a venturi means that the speed is increased (through the venturi) so that a more intensive rotational field is established. The second set of blades 8 that stops the rotation is arranged at the outlet of the venturi, where the speed increases again. This results in equivalent liquid separation and stratified gas/liquid flow as in the example shown in the figure.

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